

REMARKS

Claims 1, 3, 4, 5, 8 and 9 have been amended merely to accord with standard U.S. practice and these amendments do not, and are not intended to, effect the scope of these claims.

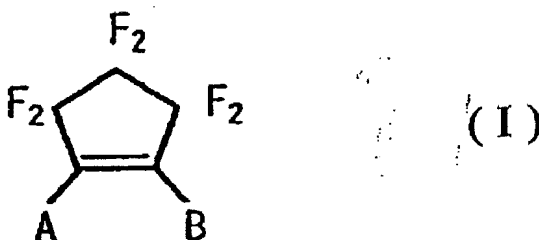
Claims 1-9 remain active and under consideration in this case.

REQUEST FOR RECONSIDERAION

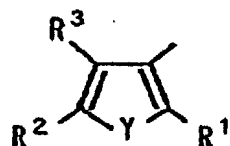
Photochromic compounds can reversibly exist, for example, as either of two isomers by photoisomerization. Conventional photochromic compounds suffer from large ring opening quantum yield ($\Phi_{c \rightarrow o}$) values, which resulted in fading of the color afforded by these compounds upon exposure to visible light.

Advantageously, it has now been determined that certain diarylethene compounds having a ring opening quantum yield of $< 10^{-3}$ are resistant to fading upon exposure to visible light. That is, it has been discovered that a particular molecular structure is required to obtain a ring opening quantum yield of $< 10^{-3}$ in order to attain resistance to fading under visible light.

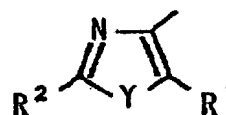
In particular, the compounds of present Claim 1, which are photochromic materials having a ring opening quantum yield of 10^{-3} or lower, have the formula:



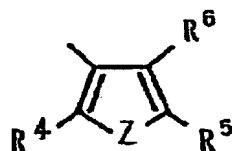
wherein in the formula (I), A represents substituents (i) or (ii), and B represents substituents (iii) or (iv);



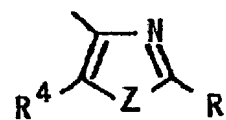
(i)



(ii)



(iii)



(iv)

wherein, in substituents (i) and (ii), R^1 represents an alkoxy group, R^2 represents $-Q-Ar$, Q represents a direct bond or a divalent group and Ar represents an aromatic hydrocarbon ring or an aromatic heterocycle which are optionally substituted, R^3 represents a hydrogen atom, an alkyl group, an alkoxy group, a halogen atom, a fluoroalkyl group, a cyano group or an aryl group which is optionally substituted, and Y represents $-O-$ or $-S-$; and

in substituents (iii) and (iv), R^4 represents an alkoxy group, R^5 represents $-Q-Ar$, Q represents a direct bond or an arbitrary divalent group and Ar represents an aromatic hydrocarbon ring or an aromatic heterocycle which are optionally substituted, R^6 represents a hydrogen atom, an alkyl group, an alkoxy group, a halogen atom, a fluoroalkyl group, a cyano group, or an aryl group which is optionally substituted, and Z represents $-O-$ or $-S-$.

Claims 1-9 stand rejected under 35 U.S.C. §103(a) as being unpatentable in view of JP 2001-49244 (Chem. Abs. 134:186014).¹

Claims 1-9 also stand rejected under 35 U.S.C. §103(a) as being unpatentable in view of JP2001-48875, JP2000-321714, JP2000-256665, JP2000-256664 and Chem. Abs. CA 121:235806 (Masahiro) in view of JP 2001-49244.²

^{1,2} Both grounds of rejection were merely repeated "as outlined in the previous Office Action dated 12/16/04" in the Final Official Action of May 31, 2005.

However, none of the above-cited references either discloses or suggests the present invention, either alone or in combination.

Notably, the compounds of present Claim 1 exhibit a particular pattern of ring substituents. In particular, these compounds have both: 1) directly bonded aryl rings or aryl rings bonded via a divalent group (R^2 and R^5), and 2) two lower alkoxy groups attached to the core thiophene rings (R^1 and R^4). With this particular substitution pattern, the compounds of Claim 1 exhibit a ring opening quantum yield of less than 10^{-3} .

Moreover, by attaining a ring opening quantum yield of less than 10^{-3} , the photochromic compounds of Claim 1 are resistant to fading upon exposure of visible light.

In contrast, none of the cited references discloses or suggests such a particular pattern of ring substituents.

For example, the cited Japanese references, by the Examiner's own admission, describe the attachment of an alkyl (instead of an alkoxy) substituent at the 2-position of the heteroaryl ring. Thus, none of these references either describes or suggests the inclusion of two lower alkoxy substituents attached to core thiophene rings as in the compounds of present Claims 1-9.

Additionally, at page 3 of the Official Action, the Examiner asserts without justification that:

...it would have been prima facie obvious to one having ordinary skill in the art at the time the application was filed to substitute alkyl with alkoxy in otherwise known diarylethene photochromic compounds, motivation being that alkyl and alkoxy have been taught to be interchangeable groups and therefore obvious variants, wherein the resultant compounds would be expected to possess the same or similar properties, absent some unobvious or unexpected results.

However, there are several problems with this position.

First, the test of obviousness is determined as of the time the present invention was made, not when the application was filed.

Second, the compounds of present Claims 1-9 are not "otherwise known" but for the replacement of alkyl groups with alkoxy groups. In fact, the compounds of present Claims 1-9 also require directly bonded, but not fused, aryl rings in addition to two lower alkoxy groups attached to the core thiophene rings.

Third, there is no evidence of record that would even remotely suggest that alkyl and alkoxy groups are interchangeable in photochromic compounds, i.e., having no discernably different effect on photoisomerization reactions.

However, even assuming for the sake of argument, that the compounds of present Claim 1 would have been obvious to one skilled in the art at the time the present invention was made, attached to this Amendment is the executed Rule 132 Declaration of the inventor, Masahiro Irie.

In the Declaration, representative diarylethene compounds of present Claim 1 (Table 2) were compared with representative conventional diarylethene compounds (Table 1) and representative diarylethene compounds of the cited references (Table 3) by testing using the same procedures as in the present specification in order to measure the ring opening quantum yield ($\Phi_{c \rightarrow o}$) and the ring closing quantum yield ($\Phi_{o \rightarrow c}$). The results are shown in Tables 1-3 of the Declaration.

Several observations were made and a conclusion drawn therefrom.

First, the presence of fused benzene rings attached to the core thiophene rings in the conventional diarylethenes in Table 1 do not afford a ring opening quantum yield of less than 10^{-3} despite the fact that these compounds contain two lower alkoxy groups attached to the core thiophene rings.

Second, the presence of directly bonded, but not fused, aryl rings and two lower alkoxy groups attached to the core thiophene rings in the compounds of the present invention in Table 2 do afford

a ring opening quantum yield of less than 10^{-3} .

Third, the presence of directly bonded, but not fused, aryl rings, but only one lower alkoxy group attached to the core thiophene rings in the compounds of the Japanese patents cited in the Official Action of December 16, 2004, in Table 3 do not afford a ring opening quantum yield of less than 10^{-3} .

Thus, in view of the above observations, it is concluded that only with the present compounds as reflected in Claims 1-9 of the present application - which have both: 1) directly bonded aryl rings or aryl rings bonded via a divalent group (R^2 and R^5) and 2) two lower alkoxy groups attached to the core thiophene rings (R^1 and R^4), a ring opening quantum yield of less than 10^{-3} can be obtained, which is important in order to afford resistance to fading upon exposure to visible light.

The results afforded by the compounds of Claims 1-9 are important and commercially significant. The record or image of an optical memory medium or optical display material of a photochromic material may disappear under ambient light, such as a room light. When the quantum yield of ring opening reaction (known as "ring opening quantum yield") of a diarylethene compound in a closed ring form is on the order of 10^{-2} , the record or image disappears almost completely in several hours under fluorescent room lighting. Thus, it is desirable to attain a reduced ring opening quantum yield of less than 10^{-3} . The compounds of the present inventions as represented by Claims 1-9 accomplish this result.

Further, the importance and commercial significance of obtaining a ring opening quantum yield of less than 10^{-3} may be readily appreciated from Examples 1-4 (paragraphs [0041] - [0071] of the present specification) wherein it is seen that with a ring opening quantum yield of less than 10^{-3} the compounds of present Claims 1-9 exhibit photochromism such that upon exposure to irradiation with visible light little or no fading was observed.

Hence, on the basis of all of the above, both grounds of rejection

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PATENT

are believed to be unsustainable and should be withdrawn.

Accordingly, it is believed that this application is now in condition for allowance. Early notice to this effect is earnestly solicited.

Respectfully submitted,

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